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Bernard

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(54) **MULTIMODAL NATURAL LANGUAGE QUERY SYSTEM FOR PROCESSING AND ANALYZING VOICE AND PROXIMITY-BASED QUERIES**

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G06F 17/27	(2006.01)
G10L 15/30	(2013.01)
G10L 15/18	(2013.01)

(52) **U.S. Cl.**

CPC ***G06F 17/2785*** (2013.01); ***G06F 17/30017*** (2013.01); ***G06F 17/30654*** (2013.01); ***G10L 15/30*** (2013.01); *G10L 15/18* (2013.01); *Y10S 707/918* (2013.01)

(58) **Field of Classification Search**

CPC G06F 17/30017; G06F 17/30654; G06F 17/2785

See application file for complete search history.

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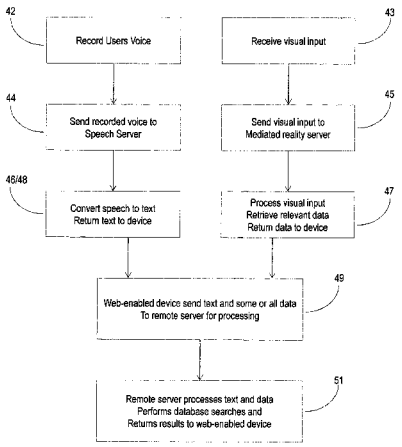
(57) **ABSTRACT**

The disclosure provides a natural language query system and method for processing and analyzing multimodally-originated queries, including voice and proximity-based queries. The natural language query system includes a Web-enabled device including a speech input module for receiving a voice-based query in natural language form from a user and a location/proximity module for receiving location/proximity information from a location/proximity device. The query system also includes a speech conversion module for converting the voice-based query in natural language form to text in natural language form and a natural language processing module for converting the text in natural language form to text in searchable form. The query system further includes a semantic engine module for converting the text in searchable form to a formal database query and a database-look-up module for using the formal database query to obtain a result related to the voice-based query in natural language form from a database.

13 Claims, 6 Drawing Sheets



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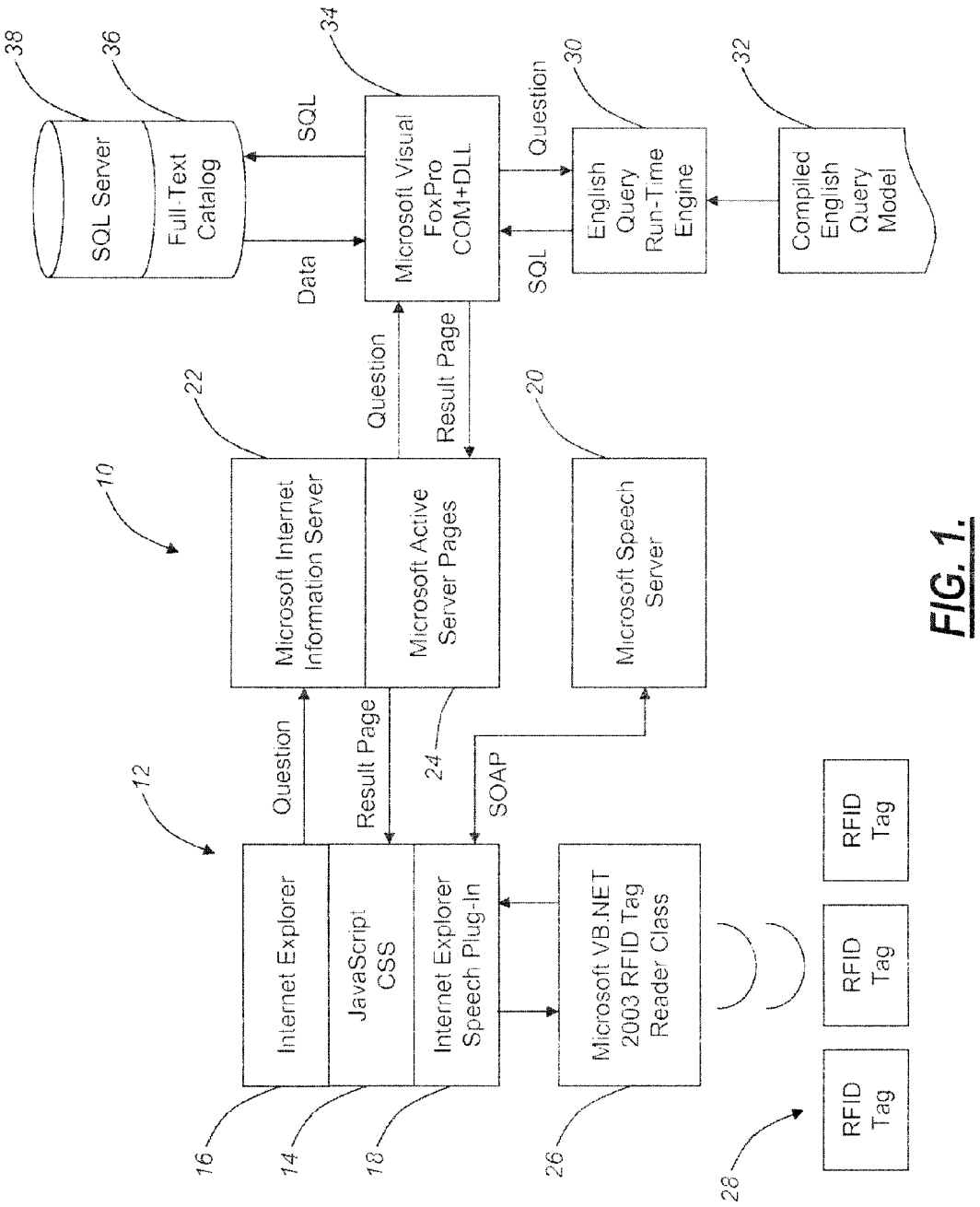
38
36
34
30
32
SQL Server
Full-Text Catalog
SQL
Data
Microsoft Visual FoxPro COM+DLL
Question
SQL
English Query Run-Time Engine
Compiled English Query Model
22
20
10
Question
Result Page
Microsoft Internet Information Server
Microsoft Active Server Pages
Microsoft Speech Server
12
Question
Result Page
24
SOAP
Internet Explorer
JavaScript CSS
Internet Explorer Speech Plug-In
Microsoft VB.NET 2003 RFID Tag Reader Class
RFID Tag
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RFID Tag
16
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FIG. 1.

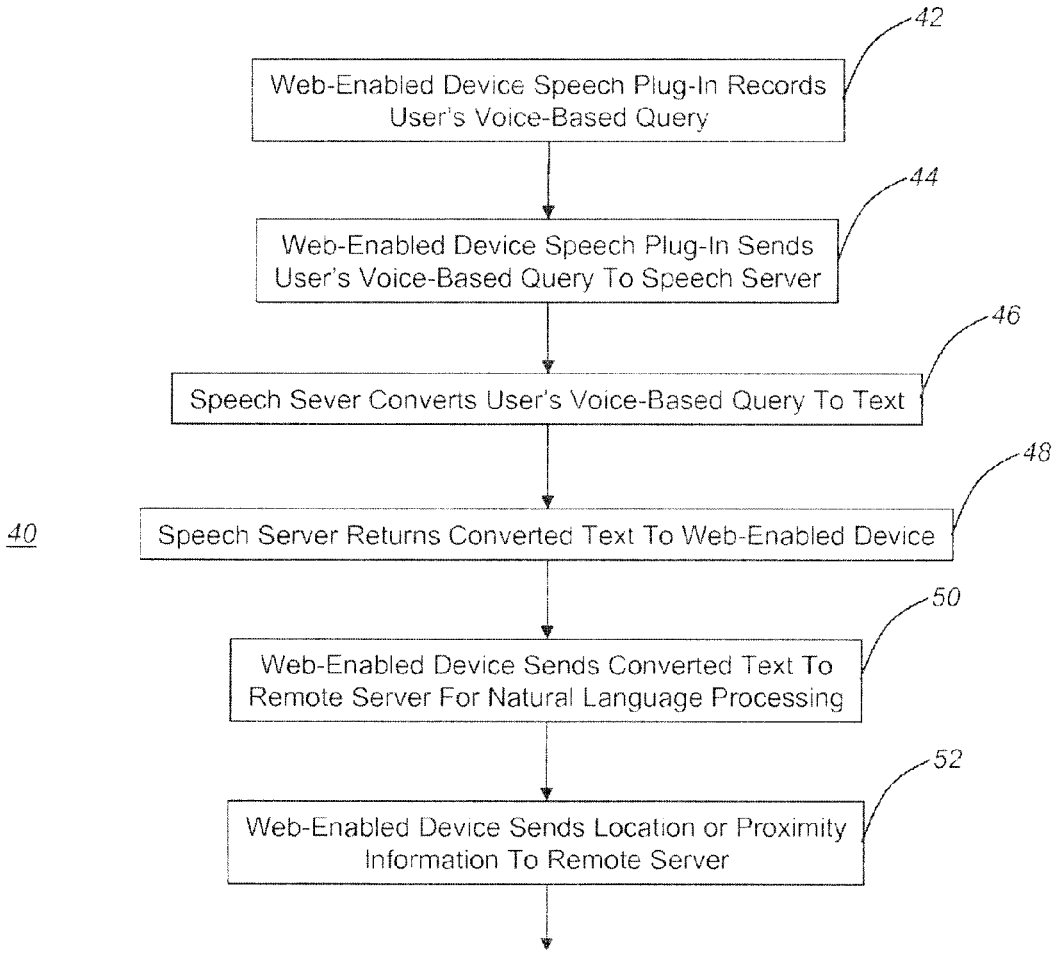
40
Web-Enabled Device Speech Plug-In Records User's Voice-Based Query
42
Web-Enabled Device Speech Plug-In Sends User's Voice-Based Query To Speech Server
44
Speech Sever Converts User's Voice-Based Query To Text
46
Speech Server Returns Converted Text To Web-Enabled Device
48
Web-Enabled Device Sends Converted Text To Remote Server For Natural Language Processing
50
Web-Enabled Device Sends Location or Proximity Information To Remote Server
52

FIG. 2.

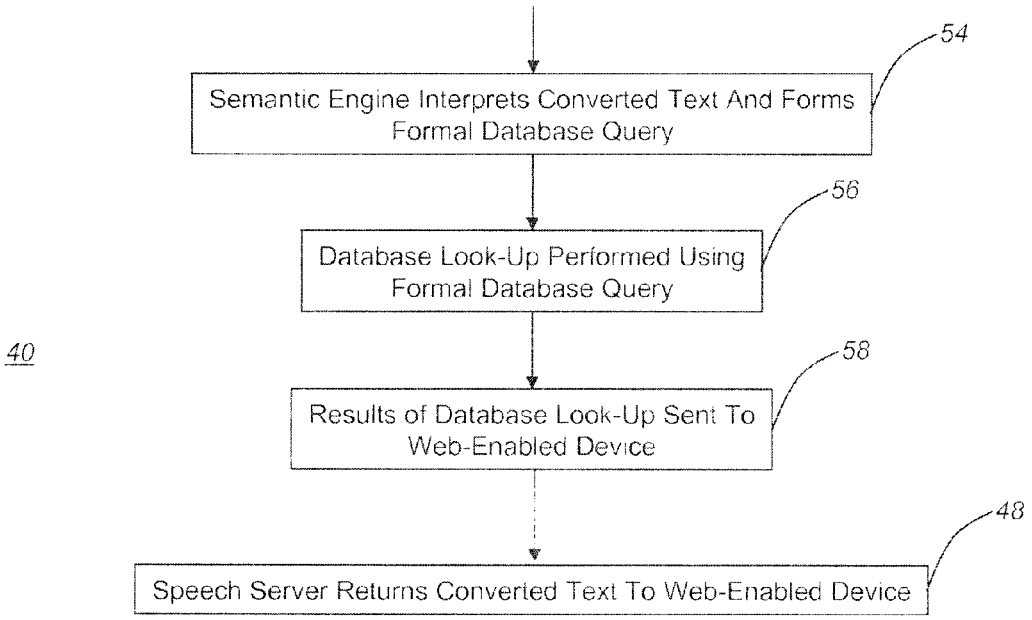
40
Semantic Engine Interprets Converted Text And Forms Formal Database Query
54
Database Look-Up Performed Using Formal Database Query
56
Results of Database Look-Up Sent To Web-Enabled Device
58
Speech Server Returns Converted Text To Web-Enabled Device
48

FIG. 3.

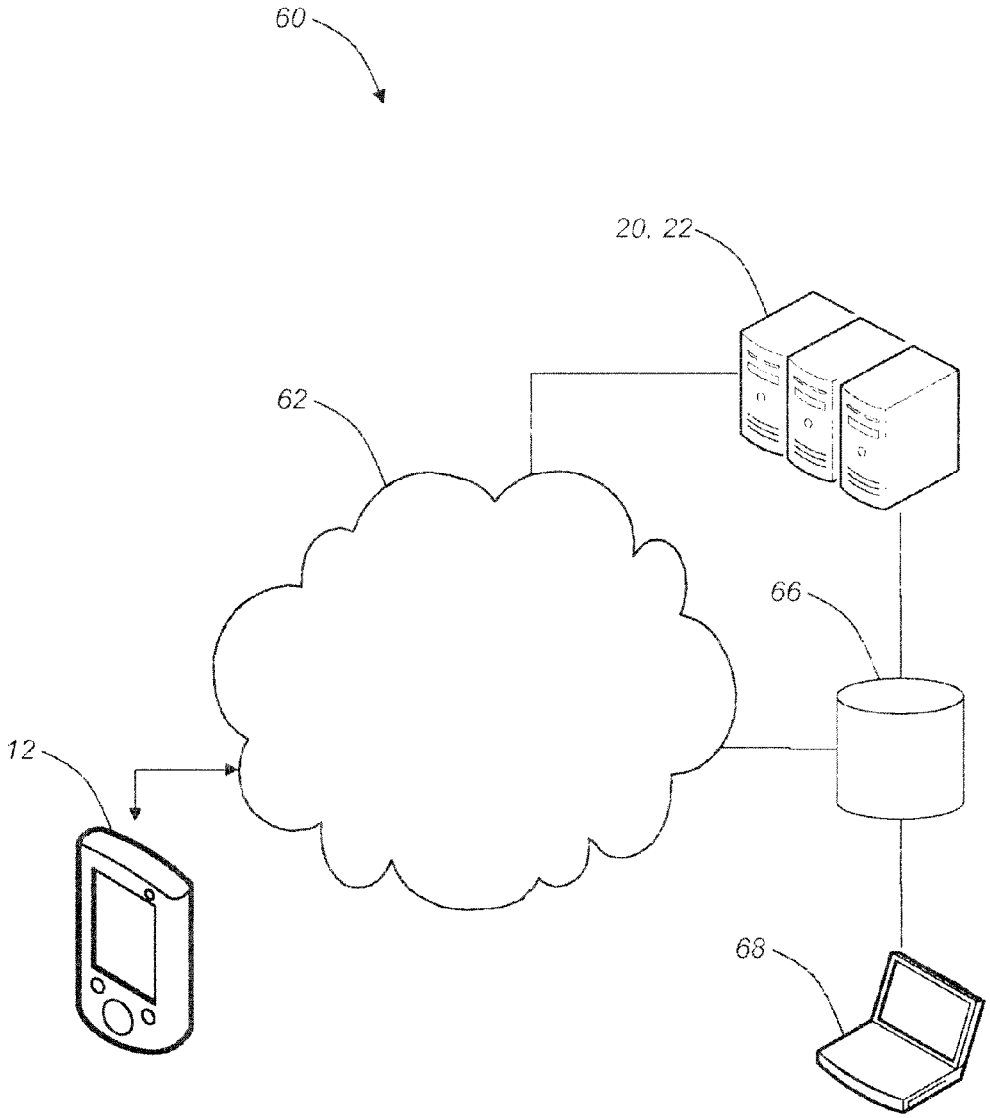

FIG. 4.

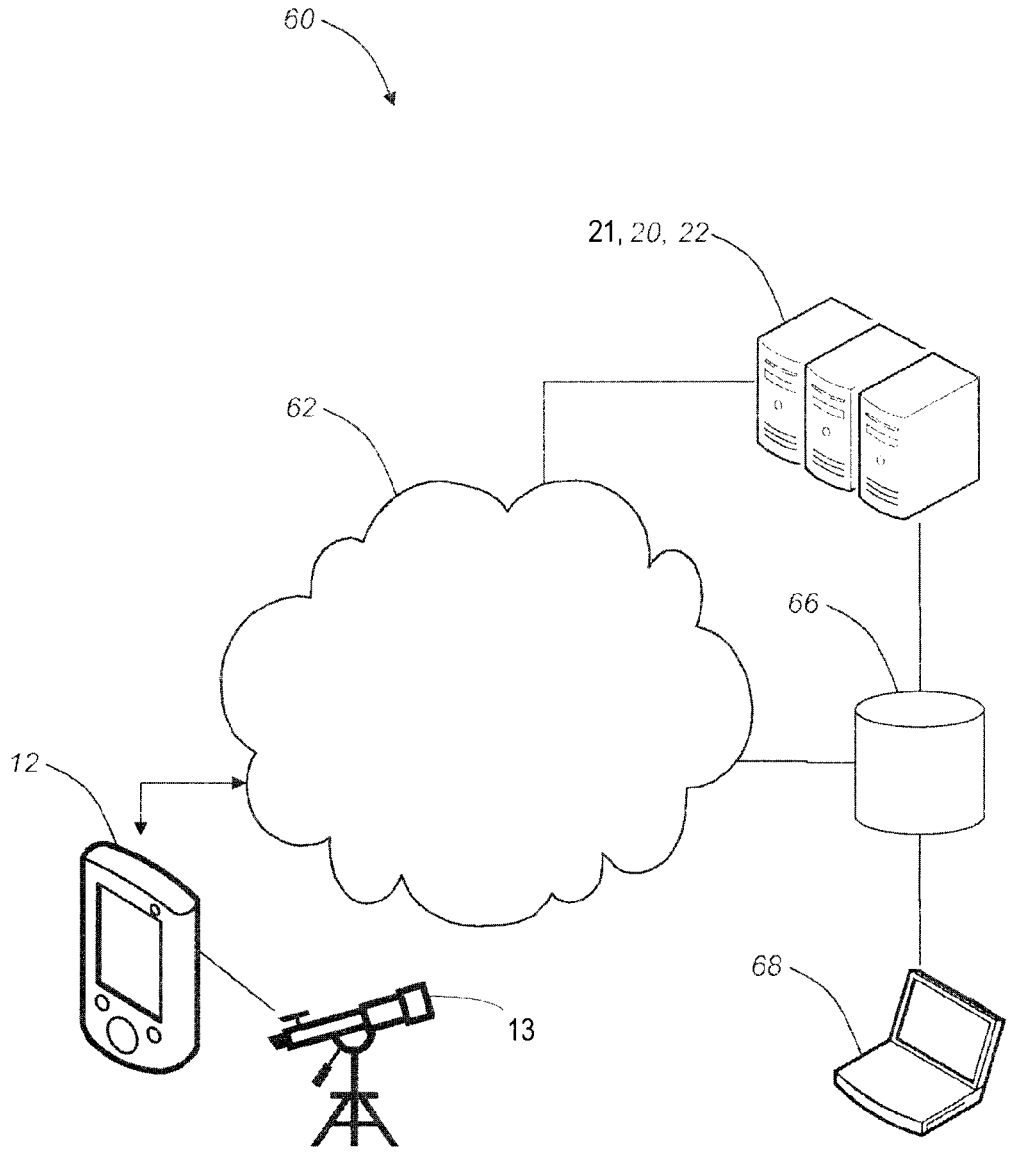

FIG. 5.

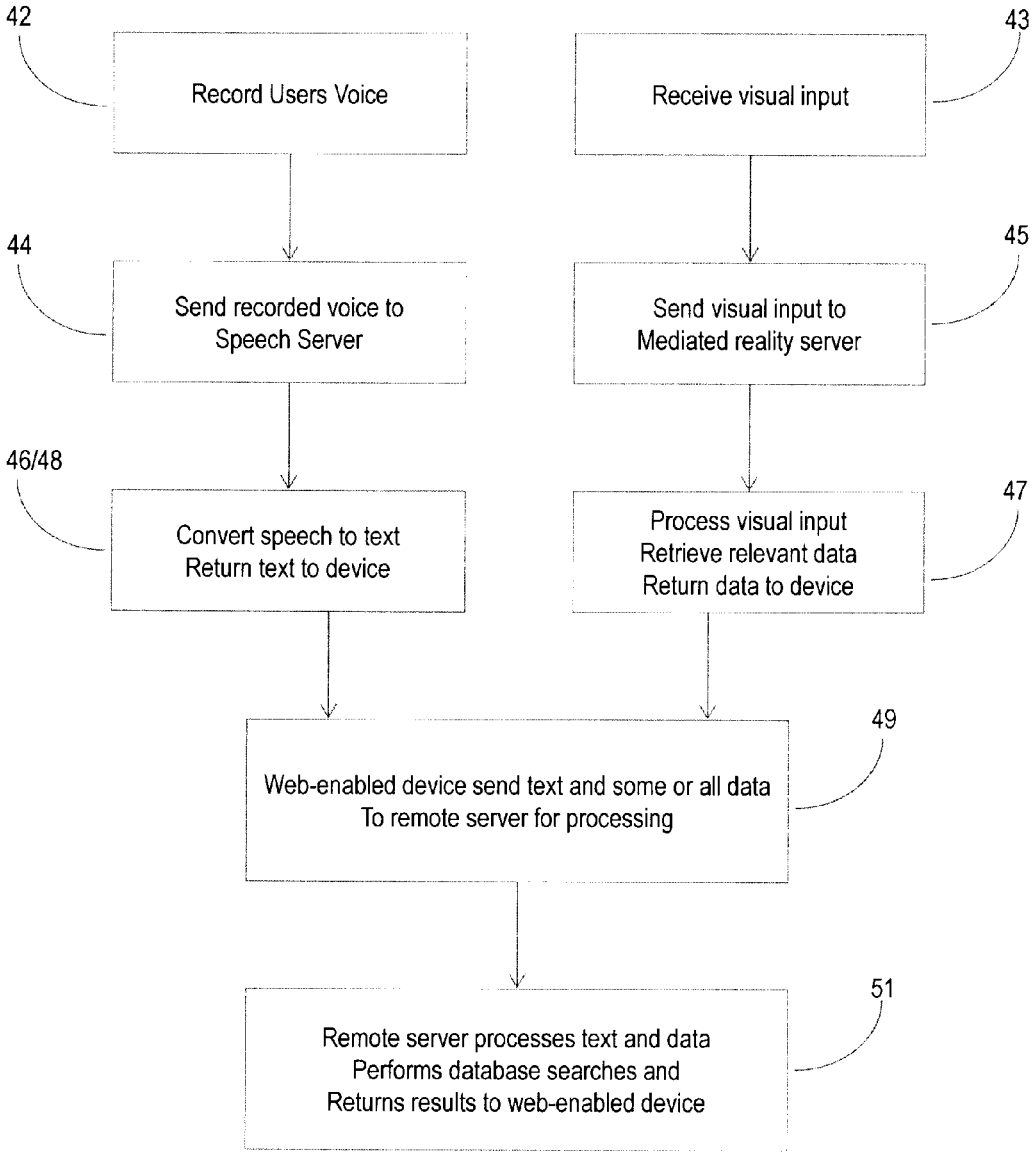
42
Record Users Voice
43
Receive visual input
44
Send recorded voice to Speech Server
45
Send visual input to Mediated reality server
46/48
Convert speech to text Return text to device
47
Process visual input Retrieve relevant data Return data to device
49
Web-enabled device send text and some or all data To remote server for processing
51
Remote server processes text and data Performs database searches and Returns results to web-enabled device

FIG. 6.

MULTIMODAL NATURAL LANGUAGE QUERY SYSTEM FOR PROCESSING AND ANALYZING VOICE AND PROXIMITY-BASED QUERIES

CROSS-REFERENCE TO RELATED APPLICATION(S)

This application is a continuation-in-part of co-pending U.S. patent application Ser. No. 13/431,966 filed Mar. 27, 2012 and entitled "MULTIMODAL NATURAL LANGUAGE QUERY SYSTEM AND ARCHITECTURE FOR PROCESSING AND ANALYZING VOICE AND PROXIMITY-BASED QUERIES," which is a continuation of U.S. Pat. No. 8,150,872 issued Apr. 3, 2012, and entitled "MULTIMODAL NATURAL LANGUAGE QUERY SYSTEM AND ARCHITECTURE FOR PROCESSING AND ANALYZING VOICE AND PROXIMITY-BASED QUERIES," which is a continuation-in-part of U.S. Pat. No. 7,873,654 issued Jan. 18, 2011 and entitled "MULTIMODAL NATURAL LANGUAGE QUERY SYSTEM AND ARCHITECTURE FOR PROCESSING VOICE AND PROXIMITY-BASED QUERIES," which is a continuation-in-part of U.S. Pat. No. 7,376,645 issued May 20, 2008, and entitled "MULTIMODAL NATURAL LANGUAGE QUERY SYSTEM AND ARCHITECTURE FOR PROCESSING VOICE AND PROXIMITY-BASED QUERIES," the contents of each are incorporated in full by reference herein.

FIELD OF THE INVENTION

The invention relates generally to a multimodal natural language query system for processing voice and proximity-based queries. More specifically, the invention relates to a multimodal natural language query system for processing voice and proximity-based queries including a location or proximity system or device, such as a global positioning system (GPS), radio frequency identification (RFID) device, or the like. This location or proximity system or device provides the multimodal natural language query system and architecture with a plurality of advanced capabilities.

BACKGROUND OF THE INVENTION

The use of personal computers (PCs), personal digital assistants (PDAs), Web-enabled phones, smart phones, tablet devices, wireline and wireless networks, the Internet, Web-based query systems and engines, and the like has gained relatively widespread acceptance in recent years. This is due, in large part, to the relatively widespread availability of high-speed, broadband Internet access through digital subscriber lines (DSLs) (including asymmetric digital subscriber lines (ADSLs) and very-high-bit-rate digital subscriber lines (VDSLs)), cable modems, satellite modems, wireless local area networks (WLANs), 3G/4G wireless systems, and the like. Thus far, user interaction with PCs, PDAs, smart phones, tablet devices, Web-enabled phones, wireline and wireless networks, the Internet, Web-based query systems and engines, and the like has been primarily non-voice-based, through keyboards, mice, intelligent electronic pads, monitors, touch screens, printers, and the like. This has limited the adoption and use of these devices and systems somewhat, and it has long been felt that allowing for accurate, precise, and reliable voice-based user interaction, mimicking normal human interaction, would be advantageous. For example, allowing for accurate, precise, and reliable voice-based user interaction would certainly draw more users to e-commerce, e-support, e-learning, etc., and reduce learning curves.

In this context, "mimicking normal human interaction" means that a user would be able to speak a question into a Web-enabled device or the like and the Web-enabled device or the like would respond quickly with an appropriate answer or response, through text, graphics, or synthesized speech, the Web-enabled device or the like not simply converting the user's question into text and performing a routine search, but understanding and interpreting the user's question. Thus, if the user speaks a non-specific or incomplete question into the Web-enabled device or the like, the Web-enabled device or the like would be capable of inferring the user's meaning based on context or environment. This is only possible through multimodal input.

Several software products currently allow for limited voice-based user interaction with PCs, PDAs, and the like. Such software products include, for example, ViaVoice™ by International Business Machines Corp. and Dragon NaturallySpeaking™ by Scansoft, Inc. These software products, however, allow a user to perform dictation, voice-based command-and-control functions (opening files, closing files, etc.), and voice-based searching (using previously-trained uniform resource locators (URLs)), only after time-consuming, and often inaccurate, imprecise, and unreliable, voice training. Their accuracy rates are inextricably tied to a single user that has provided the voice training.

Typical efforts to implement voice-based user interaction in a support and information retrieval context may be seen in U.S. Pat. No. 5,802,526, to Fawcett et al. (Sep. 1, 1998). Typical efforts to implement voice-based user interaction in an Internet context may be seen in U.S. Pat. No. 5,819,220, to Sarukkai et al. (Oct. 6, 1998).

U.S. Pat. No. 6,446,064, to Livowsky (Sep. 3, 2002), discloses a system and method for enhancing e-commerce using a natural language interface. The natural language interface allows a user to formulate a query in natural language form, rather than using conventional search terms. In other words, the natural language interface provides a "user-friendly" interface. The natural language interface may process a query even if there is not an exact match between the user-formulated search terms and the content in a database. Furthermore, the natural language interface is capable of processing misspelled queries or queries having syntax errors. The method for enhancing e-commerce using a natural language interface includes the steps of accessing a user interface provided by a service provider, entering a query using a natural language interface, the query being formed in natural language form, processing the query using the natural language interface, searching a database using the processed query, retrieving results from the database, and providing the results to the user. The system for enhancing e-commerce on the Internet includes a user interface for receiving a query in natural language form, a natural language interface coupled to the user interface for processing the query, a service provider coupled to the user interface for receiving the processed query, and one or more databases coupled to the user interface for storing information, wherein the system searches the one or more databases using the processed query and provides the results to the user through the user interface.

U.S. Pat. No. 6,615,172, to Bennett et al. (Sep. 2, 2003), discloses an intelligent query system for processing voice-based queries. This distributed client-server system, typically implemented on an intranet or over the Internet accepts a user's queries at the user's PC, PDA, or workstation using a speech input interface. After converting the user's query from speech to text, a two-step algorithm employing a natural

language engine, a database processor, and a full-text structured query language (SQL) database is implemented to find a single answer that best matches the user's query. The system, as implemented, accepts environmental variables selected by the user and is scalable to provide answers to a variety and quantity of user-initiated queries.

U.S. Patent Application Publication No. 2001/0039493, to Pustejovsky et al. (Nov. 8, 2001), discloses, in an exemplary embodiment, a system and method for answering voice-based queries using a remote mobile device, e.g., a mobile phone, and a natural language system.

U.S. Patent Application Publication No. 2003/0115192, to Kil et al. (Jun. 19, 2003), discloses, in various embodiments, an apparatus and method for controlling a data mining operation by specifying the goal of data mining in natural language, processing the data mining operation without any further input beyond the goal specification, and displaying key performance results of the data mining operation in natural language. One specific embodiment includes providing a user interface having a control for receiving natural language input describing the goal of the data mining operation from the control of the user interface. A second specific embodiment identifies key performance results, providing a user interface having a control for communicating information, and communicating a natural language description of the key performance results using the control of the user interface. In a third specific embodiment, input data determining a data mining operation goal is the only input required by the data mining application.

U.S. Patent Application Publication No. 2004/0044516, to Kennewick et al. (Mar. 4, 2004), discloses systems and methods for receiving natural language queries and/or commands and executing the queries and/or commands. The systems and methods overcome some of the deficiencies of other speech query and response systems through the application of a complete speech-based information query, retrieval, presentation, and command environment. This environment makes significant use of context, prior information, domain knowledge, and user-specific profile data to achieve a natural language environment for one or more users making queries or commands in multiple domains. Through this integrated approach, a complete speech-based natural language query and response environment may be created. The systems and methods create, store, and use extensive personal profile information for each user, thereby improving the reliability of determining the context and presenting the expected results for a particular question or command.

U.S. Patent Application Publication No. 2004/0117189, to Bennett (Jun. 17, 2004), discloses an intelligent query system for processing voice-based queries. This distributed client-server system, typically implemented on an intranet or over the Internet, accepts a user's queries at the user's PC, PDA, or workstation using a speech input interface. After converting the user's query from speech to text, a natural language engine, a database processor, and a full-text Structured Query Language (SQL) database are implemented to find a single answer that best matches the user's query. Both statistical and semantic decoding are used to assist and improve the performance of the query recognition.

Each of the systems, apparatuses, software products, and methods described above suffers from at least one of the following shortcomings. Several of the systems, apparatuses, software products, and methods require time-consuming, and often inaccurate, imprecise, and unreliable, voice training. Several of the systems, apparatuses, software products, and methods are single-modal, meaning that a user may interact with each of the systems, apparatuses, software products, and methods in only one way, i.e. each utilizes only a single voice-based input. As a result of this single-modality, there is no context or environment within which a voice-based search is performed and several of the systems, apparatuses, software products, and methods must perform multiple iterations to pinpoint a result or answer related to the voice-based search.

Thus, what is needed are natural language query systems and methods for processing voice and proximity-based queries that do not require time-consuming, and often inaccurate, imprecise, and unreliable, voice training. What is also needed are natural language query systems and methods that are multimodal, meaning that a user may interact with the natural language query systems and methods in a number of ways simultaneously and that the natural language query systems and methods utilize multiple inputs in order to create and take into consideration a context or environment within which a voice and/or proximity-based search or the like is performed. In other words, what is needed are natural language query systems and methods that mimic normal human interaction, attributing meaning to words based on the context or environment within which they are spoken. What is further needed are natural language query systems and methods that perform only a single iteration to pinpoint a result or answer related to a voice and/or proximity-based search or the like.

BRIEF SUMMARY OF THE INVENTION

In various embodiments, the invention provides a natural language query system and method for processing voice and proximity-based queries that do not require time-consuming, and often inaccurate, imprecise, and unreliable, voice training. The invention also provides a natural language query system and method that are multimodal, meaning that a user may interact with the natural language query system and method in a number of ways simultaneously and that the natural language query system and method utilize multiple inputs in order to create and take into consideration a context or environment within which a voice and/or proximity-based search or the like is performed. In other words, the invention provides a natural language query system and method that mimic normal human interaction, attributing meaning to words based on the context or environment within which they are spoken. This context or environment may be prior information-based, domain knowledge-based, user-specific profile data-based, and/or, preferably, location or proximity-based. The invention further provides a natural language query system and method that perform a single iteration to pinpoint a result or answer related to a voice and/or proximity-based search or the like.

Functionally, the invention provides a natural language query system and method that do more than simply convert speech to text, use this text to search a database, and convert text to speech. The natural language query system and method of the invention are capable of receiving speech as input and providing appropriate and useful responses. Off-the-shelf tools are used to incorporate and combine speech recognition, natural language processing (NLP)(also referred to as natural language understanding) and speech synthesis technologies. NLP deciphers grammar (how words connect and how their definitions relate to one another), context, and environment.

In an exemplary embodiment, a query system includes a computing device in electrical communication with a network, which is configured to receive audio input and determine location information; and a server in electrical communication with the computing device via the network, wherein

the server is configured to: receive a query from the computing device; perform natural language processing on the query using lexicons and grammar rules to determine a meaning of the query; utilize location information to further determine the meaning of the query; and perform a database look up based on the determined meaning of the query. The computing device may be a smart phone, a tablet device, a laptop computer, an e-reader, and may include a camera, binoculars a telescope, etc. The computing device may include Global Positioning Satellite functionality providing location information. The computing device further may include a Radio Frequency Identification scanner for providing the location information. The query system may further include a user database configured to store a plurality of queries from a plurality of users, and the server is further configured to determine the meaning of the query based upon data in the user database. The query system may further include a plurality of databases communicatively coupled to the server. The query system may further include a middleware application executed on the server, wherein the middleware application is configured to route the query to one or more of the plurality of databases and to rank accuracy of results from the one or more of the plurality of databases. The query system may further include a semantic engine module executed on the server for converting the determined query to a formal database query. The query system may further include a speech conversion module executed on the server for converting the query in audio and natural language form to text in natural language form. The query system may further include a natural language processing module executed on the server for converting the text in natural language form to text in searchable form using lexicons and grammar rules to parse sentences and determine underlying meanings of the query.

In another exemplary embodiment, a mobile device query method, includes receiving an audio query from a user; determining location information of the user based on Global Positioning Satellite functionality and/or Radio Frequency Identification readings; transmitting the audio query and the location information to a server; and receiving a plurality of responses to the audio query from the server, each of the plurality of responses is ranked by the server using an accuracy algorithm.

In yet another exemplary embodiment, a query method includes receiving an audio query and location information; converting the audio query into text in a natural language form; converting the text in a natural language form to text in searchable form using lexicons and grammar rules to parse sentences and determine underlying meanings of the audio query; determining a formal database query from the text in searchable form; and performing a database lookup based on the formal database query. The query method of may further include sending the formal database query to a plurality of databases including constrained semantic models; and ranking results from the plurality of databases.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is illustrated and described herein with reference to the various drawings, in which like reference numbers denote like method steps and/or system components, respectively, and in which:

FIG. **1** is a schematic diagram illustrating an embodiment of a multimodal natural language query system and architecture for processing voice and proximity-based queries in accordance with aspects of the invention;

FIG. **2** is a flow chart illustrating an embodiment of the multimodal natural language query method for processing voice and proximity-based queries in accordance with aspects of the invention;

FIG. **3** is a continuing flow chart of FIG. **2**;

FIG. **4** is a diagram illustrating an exemplary embodiment of the invention with a Web-enabled device connected to a speech server, a remote server, and the like to perform a natural language query over a network, such as the Internet or the like;

FIG. **5** is a diagram illustrating another exemplary embodiment of the invention illustrating a visual input device and a mediated reality server; and,

FIG. **6** is a flow chart illustrating an embodiment of the query method for processing voice and visual input in accordance with aspects of the invention.

The invention will next be described in connection with certain illustrated embodiments and practices. However, it will be clear to those skilled in the art that various modifications, additions and subtractions can be made without departing from the spirit or scope of the claims.

DETAILED DESCRIPTION OF THE INVENTION

In general, the natural language query system and method of the invention may incorporate and combine the following technologies:

1. Speech Processing—Speech processing allows PCs, PDAs, Web-enabled phones, smart phones, tablet devices, and the like to recognize—and, to some extent, understand—spoken language. Spoken language is "eyes free" and "hands free", allowing a PC, PDA, Web-enabled phone, smart phone, tablet device, or the like to be used anywhere. This technology has engendered two types of software products: continuous-speech recognition software products and command-and-control software products. Because a context-free grammar allows a speech recognition engine to reduce recognized words to those contained in a predetermined list, high degrees of speech recognition may be achieved in a speaker-independent environment. A context-free grammar may be used with relatively inexpensive microphones, limited central processing units (CPUs), and no time-consuming, and often inaccurate, imprecise, and unreliable, voice training. Although speech processing technology is not new, speech recognition accuracy rates are just now becoming acceptable for natural language discourse.

2. Speech Synthesis—The ability to mimic speech is useful for applications that require spontaneous user interaction, or in situations where viewing or reading are impractical, such as, for example, when a PC, PDA, Web-enabled phone, smart phone, tablet device, or the like provide driving directions or instructions to the driver of a vehicle. In software products aimed at the average user, it is important that output sounds are pleasant and sound human enough to encourage regular use. Several software products now bring relatively inexpensive and effective conversational access to information applications and accelerate the acceptance of speech as a user interface alternative for Web-based and mobile applications, including, for example, Microsoft Speech Server by Microsoft Corp. Microsoft Speech Server currently supports eight languages and is based on the open-standard Speech Application Language Tags (SALT) specification, which extends familiar mark-up languages and leverages the existing Web-development paradigm.

3. Natural Language Processing (NLP) systems interpret written, rather than spoken, language and may be found in speech processing systems that begin by converting spoken

input into text. Using lexicons and grammar rules, NLP parses sentences, determines underlying meanings, and retrieves or constructs responses. NLP technology's main use is in enabling databases to answer queries presented in the form of questions. Another use is in handling high-volume email. NLP performance may be improved by incorporating a common sense knowledge base—that is, a set of real-world rules. Almost all of the database query languages tend to be rigid and difficult to learn, and it is often difficult for even the most experienced user to get desired information out of a database. A natural language interface to the SQL language overcomes the need for users to master the complexities of the SQL language.

4. English Query—English query (EQ) is a component of Microsoft SQL Server 2000 by Microsoft Corp. that allows users to query databases using plain English. The EQ engine creates a database query that may be executed under program control to return a formatted answer. The development process is at a higher level than traditional programming, but may be mastered by non-programmers with some database background. In order to implement natural language searching, an authoring tool is used to provide domain knowledge to the EQ engine, and to relate database entities to objects in the domain. EQ uses verb relationships and the like to perform natural language parsing of users' questions, which provides better search results than keyword-based technologies. The goal of EQ is to identify and model all of the relationships between entities in a database, creating a semantic model that defines a knowledge domain. This enables EQ to provide answers to a relatively wide range of questions without having to identify those questions in advance.

5. Input Devices—Adding speech recognition capability to an EQ application with a microphone or the like allows a user to type or speak a question to the EQ application. Such a speech interface may also be incorporated into a PDA, smart phone, tablet device, etc. with wireless networking capability. The combination of speech recognition and EQ represents a powerful method for a user to quickly access information in a SQL Server database. Additionally, other mechanisms can be utilized for the speech input, such as voice over Internet Protocol (VoIP) and other Internet telephony mechanisms, instant messenger (IM), and the like.

6. Multimodality—Multimodality combines graphics, text, audio, and avatar output with text, ink, speech, body attitude, gaze, RFID, GPS, and touch input to provide a greatly enhanced user experience. It is enabled by the convergence of voice, data, and content, and by multimedia, Internet protocol (IP), speech, and wireless technologies hosted on a wide range of devices and device combinations. As compared to single-modal visual and voice applications, multimodal applications are more intuitive and easier to use. A user may select how to best interact with an application, which is especially useful with newer, smaller-form-factor devices. When modalities are used contemporaneously, the resulting decrease in mutual disambiguation (MD) input error rates improve accuracy, performance, and robustness.

7. Radio Frequency Identification—RFID is a generic term for technologies that automatically identify one or more objects via radio waves, using a unique serial number stored in a RFID tag. The RFID tag's antenna, tuned to receive a RFID reader's electromagnetic waves in real time, is able to transmit identification information to the RFID reader. The RFID reader converts the radio waves received from the RFID tag into digital information which, in turn, may be passed on to a business system for processing and/or storage. RFID reader technology may be integrated with PDAs via a PC Card implementation. RFID tags tend to be small and lightweight and may be read through nonmetallic materials. The RFID reader does not have to touch a RFID tag, making RFID ideal for adverse and/or unclean environments. Likewise, RFID does not require line of sight between a tag and a reader, allowing the tags to be hidden under the skin, inside clothes, within the pages of a book, etc., preserving the items usability and aesthetics. RFID tags come in two varieties: passive (low power, short range, and relatively inexpensive) and active (high power, long range, and relatively expensive). Preferably, the natural language query system and method of the invention utilize active RFID tags that run on their own power and transmit over long distances. The battery life of a typical active RFID tag is about five years.

8. Augmented reality—AR provides a real-time view, through a video or still image of a physical environment, whose elements are augmented by computer-generated sensory input such as sound, video, graphics or location data. It is related to the more general concept, mediated reality (MR), in which a view of reality is modified by a computer. As a result of the augmentation/modification, a person's perception of the physical environment may be enhanced. Information about the environment and its objects can be overlaid on the view of the real world (e.g. sports scores overlaid on a television display during a sporting event). Conventional AR may provide too much or too little information because the technology is not aware of what information the viewer actually wishes to add to the view. Using the invention, conventional AR/MR may be improved by providing information that the viewer requests and then allowing the viewer to interact with and/or react to the augmentation/modification/enhancement.

In an exemplary embodiment, the natural language query system and method of the invention incorporate and combine the following exemplary components:

- Web/Speech/Data Server Running Microsoft Windows 2003
- Web Server: Microsoft Internet Information Services (IIS) 6.0
- Database: Microsoft SQL Server 2000 SP4
- Microsoft SQL Server 2000 English Query with Visual Studio .NET 2003 tools
- Microsoft SQL server 2000 Full-Text Indexing
- Microsoft Speech Server 1.0
- Microsoft Speech Application SDK Version 1.0
- Simple Object Access Protocol (SOAP) 3.0
- HP iPAQ h5550 Pocket PC Running Microsoft Pocket PC 2003 Premium
- HP iPAQ FA120A PC Card Expansion Pack Plus
- Identec Solutions iCard III RFID Reader
- Identec Solutions iD2, iQ32, and iQ8 RFID Tags
- Speech Add-In For Microsoft Pocket Internet Explorer
- D-Link DI-614+ Wireless Broadband Router
- Speech Application Language tags (SALT) Protocol
- DHTML, JavaScript, VBScript (ASP), CSS
- Microsoft Visual FoxPro 8.0 SP1
- Microsoft Component Services
- Visual BASIC .NET using Visual Studio .NET 2003

It should be noted that components performing similar functions and/or achieving similar results may also be used, and are contemplated by the invention.

Referring to FIG. **1**, in an exemplary embodiment of the invention, the natural language query system **10** includes a Web-enabled device **12**, such as a portable PC (a laptop PC or the like), a PDA, a Web-enabled phone, or the like capable of accessing one or more interactive Hyper Text Mark-Up Language (HTML) or Dynamic Hyper Text Mark-Up Language (DHTML) Web pages **14** (each utilizing JavaScript, Visual

basic Scripting Edition (VBScript), Active Server Pages (ASPs), Cascading Style Sheets (CSSs), etc.) via the Internet using a resident browser application **16**, such as Internet Explorer or the like. It should be understood that FIG. **1** is a simplified representation of the natural language query system **10** for purposes of explanation. Further, it should be appreciated that FIG. **1** depicts the natural language query system **10** in an oversimplified manner, and a practical embodiment may include additional components and suitably configured processing logic to support known or conventional operating features that are not described in detail herein.

Preferably, the Web-enabled device **12** is mobile and may be relatively easily carried by a user. For example, the Web-enabled device **12** may include any of a laptop, a smart phone, a PDA, a tablet device, and the like. The Web-enabled device **12** includes a speech plug-in **18**, such as Speech Plug-In for Microsoft Pocket Internet Explorer or the like, and is in communication with a speech server **20**, such as Microsoft Speech Server 1.0 or the like. Together, the speech plug-in **18** and the speech server **20** provide the Web-enabled device **12** with the ability to receive a voice-based query from a user and convert the speech to text. Specifically, once a speak button or the like associated with the Web-enabled device **12** has been pushed, the speech plug-in **18** detects that a voice-based query has begun, records the voice-based query (FIG. **6**, **42**), and continues until silence is detected. Optionally, the display of the Web-enabled device **12** may display an audio meter that provides the user with real time feedback regarding volume, background noise, and word gaps that provide the user with an improved interactive experience with the Web-enabled device **12**. The speech plug-in **18** then sends the recorded voice-based query to the speech server **20** (FIG. **6**, **44**), which converts the voice-based query to text and returns the text to the Web-enabled device **12** (FIG. **6**, **46**/**48**). Preferably, the user's interaction with the Web-enabled device **12** takes place through a speech-enabled Web-page resident on a remote server **22** running one or more Active Server Pages (ASPs) **24**. This Web page is displayed on the display of the Web-enabled device **12**.

The Web-enabled device **12** also includes a location or proximity system or device, such as a GPS or RFID device. In the event that a RFID device is utilized, the Web-enabled device **12** includes an RFID reader **26**, such as an Identec Solutions iCard III RFID Reader or the like. The RFID reader **26** automatically and wirelessly detects and receives information continuously and in real time from one or more active RFID tags **28**, such as one or more Identec Solutions iD2 RFID Tags or the like, in the vicinity, each of the one or more RFID tags **28** associated with and containing information about an article of interest, place of interest, etc. Optionally, the RFID reader component **26** includes RFID tag reader class software that controls the interface between the browser of the web-enabled device **12** and the RFID reader engine. This RFID tag reader class software incorporates complex fuzzy logic and enables the accurate reading of the RFID tags **28** in real time in support of a mobile user. In general, the RFID reader **26** (or GPS) provides location or proximity information to the Web-enabled device **12** and the natural language query system **10**. This location or proximity information and the converted text associated with the user's voice-based query are sent to the remote server **22** for subsequent processing. That is, the natural language query system **10** may utilize the location or proximity information in conjunction with the user's voice-based query for understanding or analyzing the user's voice-based query. Based on the location or proximity information received from the RFID reader **26** and the Web-enabled device **12**, the remote server **22** retrieves a relevant set of information, images, and/or links which are sent to the Web-enabled device **12** and displayed in the form of one or more Web-pages on the display of the Web-enabled device **12**. As those of ordinary skill in the art will appreciate, most conventional Web-enabled devices **12** include GPS functionality, and the invention contemplates utilizing this GPS functionality to provide the location or proximity information.

If there are no problems with the converted text associated with the user's voice-based query, NLP is then carried out at the remote server **22**. First, a semantic engine "interprets" the text associated with the user's voice-based query and converts the text into a formal database query. The semantic engine includes an English query run-time engine **30** and a compiled English query model **32**. A database look-up is then performed using the formal database query and the result is sent back to the remote server **22** and finally the Web-enabled device **12**, which may form one or more Web-pages incorporating the result. The database look-up may be performed by Microsoft Visual FoxPro COM+DLL **34** or the like, a full-text catalog **36**, and a SQL server **38**. Advantageously, the location or proximity information and the converted text associated with the user's voice-based query received from the Web-enabled device **12** represent multimodal inputs. The location or proximity information provide a context or environment that is used to narrow and streamline the database look-up related to the converted text associated with the user's voice-based query. This is illustrated in the example below.

Optionally, the remote server **22** may also create a voice-based response that is sent to the Web-enabled device **12** and converted into a speech output. Additionally, the remote server **22** can be configured to produce a "conversational agent" or "avatar", i.e. a three-dimensional on-screen "face" that realistically expresses the words by meshing Text-to-Speak (TTS) output with a talking head. Because the natural language query system **10** is multimodal, the user can react with the natural language query system **10** by either speaking or by tapping the display of the Web-enabled device **12**. For example, when link in the results Web page is tapped, more detail, including images, may be returned to the Web-enabled device **12**.

Referring to FIGS. **2** and **3**, in another exemplary embodiment of the invention, the natural language query method **40** includes receiving a voice-based query from a user using, for example, the speech plug-in **18** (FIG. **1**) of the Web-enabled device **12** (FIG. **1**) (Block **42**) and converting the voice-based query to text using the speech server **20** (FIG. **1**) (Block **46**). Specifically, once the speak button or the like associated with the Web-enabled device **12** has been pushed, the speech plug-in **18** detects that a voice-based query has begun, records the voice-based query, and continues until silence is detected. For example, if the user is a patron visiting a particular exhibit in an art museum, the user's query may be "who painted this picture?" As described above, the display of the Web-enabled device **12** may display an audio meter that provides the user with real time feedback regarding volume, background noise, and word gaps that provide the user with an improved interactive experience with the Web-enabled device **12**. The speech plug-in **18** then sends the recorded voice-based query to the speech server **20** (Block **44**), which converts the voice-based query to text (Block **46**) and returns the converted text to the Web-enabled device **12** (Block **48**). Preferably, the user's interaction with the Web-enabled device **12** takes place through a speech-enabled Web-page resident on the remote

server **22** (FIG. **1**) running one or more ASPs **24** (FIG. **1**). This Web page is displayed on the display of the Web-enabled device **12**.

As described above, the RFID reader **26** (FIG. **1**) provides location or proximity information to the Web-enabled device **12** and the natural language query system **10** (FIG. **1**). This location or proximity information and the converted text associated with the user's voice-based query are sent to the remote server **22** for subsequent processing (Blocks **50** and **52**). For example, each of the exhibits in the art museum is preferably equipped with a corresponding RFID tag **28** (FIG. **1**). Thus, the Web-enabled device **12** and the natural language query system **10** "know" which painting the user is standing in proximity to when the user asks "who painted this picture?" Based on the location or proximity information received from the RFID reader **26** and the Web-enabled device **12**, the remote server **22** retrieves a relevant set of information, images, and/or links which are sent to the Web-enabled device **12** and displayed in the form of one or more Web-pages on the display of the Web-enabled device **12**.

If there are no problems with the converted text associated with the user's voice-based query, NLP is then carried out at the remote server **22**. First, a semantic engine "interprets" the text associated with the user's voice-based query and converts the text into a formal database query (Block **54**). The semantic engine includes an English query run-time engine **30** (FIG. **1**) and a compiled English query model **32** (FIG. **1**). A database look-up is then performed using the formal database query (Block **56**) and the result is sent back to the remote server **22** and finally the Web-enabled device **12** (Block **58**), which forms one or more Web-pages incorporating the result. Advantageously, the location or proximity information and the converted text associated with the user's voice-based query received from the Web-enabled device **12** represent multimodal inputs. The location or proximity information provide a context or environment that is used to narrow and streamline the database look-up related to the converted text associated with the user's voice-based query.

As described above, the natural language query system **10** is configured to analyze and process a query, such as, for example "who painted this picture?" A logical extension to making a query is in merging a command or directive with the query to enhance the end result. For example, take the simple query "How many three bedroom houses are for sale on Elm Street in Scranton?" A user may state the "question" as part of a command and simultaneous add value to the request: "Map all three bedroom houses that are for sale on Elm Street in Scranton and email that to Fred Jones". The natural language query system **10** may be configured to receive this command and process accordingly. Other examples of similar verb-based requests are chart and sort/order by.

Referring to FIG. **4**, in an exemplary embodiment of the invention, the Web-enabled device **12** connects to the speech server **20**, the remote server **22**, and the like to perform a natural language query over a network **62**, such as the Internet or the like. The network **62** connection can include a wireless, wired, or the like connection. The invention contemplates any physical network **62** connection and network protocol, such as IP, VoIP, Public Switched Telephone Network (PSTN), DSL, WLAN, Cellular (e.g., CDMA, GSM, and the like), cable modem, and the like. In an exemplary embodiment, the Web-enabled device **12** may include, for example, a laptop, a smart phone, a tablet device, a personal digital assistant, or the like. Further, the invention contemplates a variety of applications for communication over the network **62**, such as, but not limited to, Twitter, Instant Messaging (IM), Short Message Service (SMS). Multimedia Messaging Service (MMS), and the like.

Optionally, the servers **20**,**22** can connect to a user database **66** such as through a local area network (LAN) connection, the Internet, or the like. The user database **66** provides an infrastructure to capture detailed information about user behaviors through the Web-enabled device **12**, such as (1) the physical location of the user when a question was asked (e.g., based on the RFID tag on the Web-enabled device **12**), (2) the question asked by the user, (3) the SQL query generated by the server **20**,**22** or an error condition, if applicable, and (4) the answer generated by the server **20**,**22**. For example, the user database **66** can be configured to capture this information and other information based on user queries from multiple Web-enabled devices **12**. This captured information is, in effect, capturing behavior and insights into user's thinking not possible before. Aggregated across many users, organizational behaviors can be gleaned.

This information allows for interesting analytics to be explored. For example, the user database **66** can be connected to the Internet or a LAN and accessed by a network administrator or the like over a computer **68** for performing analysis of data stored in the user database **66**. Because a question can be asked in a myriad of ways, but will generate the same SQL query, this information can correlate result frequencies back to questions. Because the natural language query system of the invention removes many of the current barriers to getting questions answered in a timely fashion, implementation of a system is likely to unleash a flood of questions that people have wanted to ask in the past, but did not because (1) it took too long to get an answer via traditional methods or (2) because they did not have access to any tools that could do the job adequately.

Advantageously, the natural language query system removes obstacles to capture some potentially very interesting and never before measured behaviors and insights into user's thinking. For example, a user could perform frequency analysis on questions and results to get an idea of what kinds of information people in an organization are looking for the most. This could be used for optimization within the organization. Also, it is possible to discover "interesting" questions that someone deep down in the organization is asking, which may not have been noticed before. This leads to more of an atmosphere of "information democratization", where more people in the organization become more valuable because the cost to test their ideas goes to almost zero. The user database **66** could be accessed through standard mechanisms known in the art and the computer **68** could include custom analysis tools or off-the-shelf tools, such as spreadsheets, database access modules, and the like, to perform such analysis.

It follows that one unique way of presenting analytics may include a standard visual "dashboard" in which each metric is represented by an English language question/query. Dashboard presentation approaches are common in current business intelligence (BI) implementations, displaying multiple metrics at once in separate panes, often in the form of charts and graphs. Business intelligence (BI) refers to computer-based techniques used in spotting, digging-out, and analyzing business data, such as sales revenue by products and/or departments, or by associated costs and incomes. BI technologies provide historical, current, and predictive views of business operations. Common functions of business intelligence technologies are reporting, online analytical processing, analytics, data mining, business performance management, benchmarking, text mining, and predictive analytics. However, specifying how to calculate each metric is tedious

in conventional BI systems; using plain English questions to generate the metric results would be a major innovation in the space. For example, the invention may be utilized as a front-end interface to various BI systems.

In another exemplary embodiment, the invention has the ability to trace the "steps" of a person's search in chronological order, which can render the "decision tree" they used to get to their answer. For example, many users will go through a series of related questions in order to refine their search criteria; this would allow interesting types of analysis to be done across all users. An analogue to this is clinical pathways, a large standard decision tree used by physicians to analyze patient conditions and come to a diagnosis; pathways are based on a great deal of prior collected knowledge. Anaphoric referencing (meaning that you can refer to earlier queries), is used to help make the query session more natural to a human. For example, the query "Who received the highest bonus?" might be followed by "Who is his manager?" Or, for example, a person asks a question like "How many houses in Apple County have 4 bedrooms?" and the system responds "554 homes". Then the user immediately asks "How many of those have a pool?" The system recognizes that "those" refers to the most immediate past question by that user and we run a subset of that query.

Currently, research indicates high accuracy rates when a "domain" of information is constrained. For example, a system may work against a particular database (e.g., airline flights, real estate listings, etc.) and the system may render very accurate results for all kinds of questions associated with the constrained information. However, this does not scale well when applied to broader more general topics (such as the entire Google database). In an exemplary embodiment, a middleware layer may be created that can analyze an incoming question and automatically route it to one or more constrained semantic models simultaneously, and then determine which of the attempts returned the best answer instead of using a broad database. This may include an accuracy algorithm that determines accuracy on an individual domain query, "scorecarding" and ranking results from multiple domains and returning the best results to the user.

Referring to FIG. **5**, in one or more embodiments of the invention, the web enabled device **12** may include or be in communication with other hardware **13** such as a camera, telescope, binoculars or the like. Although FIG. **5** only shows a telescope **13**, the invention is not so limited. The illustration of a telescope is being used as a generic representation of a device that provides visual input to web enabled device **12**. The hardware may be integral with the web enabled device, hardwired to the device, in wireless communication with the device, removably connected (e.g. plug-and-play), etc. Using one or more of these hardware devices **13** for additional input the invention may be employed to provide additional or different modalities. For example, using conventional technologies such as mediated reality software, a person could point the additional device at an object such as a car, the night sky, a plane, etc. Using this mediated/augmented reality technology the image from the camera or other device is fed into the web enabled device **12** (FIG. **6**, **43**), which processes the image (FIG. **6**, **47**), gathers location coordinates (e.g. GPS) and retrieves data from the Internet **62** or some other network source such as a mediated reality server **21** (FIG. **6**, **47**), about the car (e.g. make, model, year, type of tires, top speed, 0-60 time, etc.), the sky (star/planet identification, constellations, etc), the plane (model, make, origin, destination, etc.). The user of the web enabled device **12** may then ask one or more questions about an item in the view. For example the user of the device **12** may ask "where can I buy new tires for this car?" The system determines what "this car" is and what type of tires need to be purchased based on the information retrieved by the mediated software. This information and the converted text associated with the user's voice-based query are sent to the remote server **22** for subsequent processing (FIG. **6**, **49**). Based on the information received from the mediated reality software and the web-enabled device **12**, the remote server **22** retrieves a relevant set of information, images, and/or links which are sent to the web-enabled device **12** and displayed in the form of one or more web-pages on the display of the web-enabled device **12** (FIG. **6**, **51**). Additionally, the web-enabled device **12** may display the additional information about the tires obtained by the mediated reality software. Those skilled in the art will recognize that some or all of the information obtained by the mediated reality software could be displayed or just the information requested by the user. The amount of information that is actually displayed is merely a design choice. Those skilled in the art will also recognize that the information provided to the user in response to the query could be provided as a web page, in a list format, in printed form, as an instant message, an email, converted back to voice, in multimedia format or any combination of these.

Although the invention has been illustrated and described herein with reference to preferred embodiments and specific examples thereof, it will be readily apparent to those of ordinary skill in the art that other embodiments and examples may perform similar functions and/or achieve like results. All such equivalent embodiments and examples are within the spirit and scope of the invention and are intended to be covered by the following claims.

What is claimed is:

1. A query system, comprising:

a computing device communicatively coupled to a network and configured to receive a plurality of inputs; wherein at least one of said inputs is an audio query and another of said inputs is a visual input;

a speech server communicatively coupled to the computing device via the network, wherein the speech server is configured to receive the audio query from the computing device, convert the audio query into a text query and return the text query to said computing device;

a mediated reality server communicatively coupled to the computing device via the network, wherein the mediated reality server is configured to receive and process the visual input to determine data relevant to said visual input and return said data relevant to said visual input to said computing device; and

a remote server communicatively coupled to the computing device via the network, wherein the remote server is configured to receive said text query and at least a portion of said data relevant to said visual input and based on the received text query and the at least a portion of said data relevant to said visual input determine a response to the query.

2. The query system according to claim **1**, wherein said speech server, said mediate reality server and said remote server are the same server.

3. The query system according to claim **1**, wherein said remote server is configured to communicate said response to said computing device and said computing device is configured to communicate said response to a user.

4. The query system according to claim **3**, wherein said computing device is configured to convert said response into audio and play said audio through a speaker.

5. The query system according to claim **3** wherein said computing device is configured to convert said response into a multi-media-based response.

6. The query system according to claim 1 wherein said speech server is further configured to convert said text query from a first language to another language.

7. The query system according to claim 1 wherein said remote server is communicatively coupled to a plurality of databases and wherein said remote server is configured to concurrently search said plurality of databases for a response to said query and rank a response determined from each of said searched databases.

8. The query system according to claim 6, wherein said rank is based on an accuracy of the results.

9. The query system according to claim 1 wherein said remote server is configured to store said query and response for further analysis.

10. A mobile device query method, comprising:

receiving an audio query from a user and a visual input from a visual input device;

transmitting said visual input to a mediated reality server;

said mediated reality server processing said visual input to derive data relevant to said visual input and return said data relevant to said visual input to said mobile device;

transmitting the audio query and the data relevant to said visual input to a remote server; and

receiving a plurality of responses to the audio query from the server, said responses being based at least in part on said data relevant to said visual input, and each of the plurality of responses being ranked by the server using an accuracy algorithm.

11. The mobile device query method according to claim 10 further comprising storing said query and said plurality of responses and using said stored responses to refine responses to an additional audio query.

12. The mobile device query method according to claim 10 further comprising receiving a plurality of queries, said remote server storing said plurality of queries and performing a frequency analysis on said plurality of queries.

13. The mobile device query method according to claim 10 further comprising said remote server receiving a plurality of queries from the user, and storing said plurality of queries and an order in which said plurality of queries is received.

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